

SECTION 02732 - FORCE MAINS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope: Specifications for force main pipe, fittings, valves, and appurtenances are included in this Section.
- B. Definitions: All pipe, fitting and valve size, and all reference to pipe diameter on the drawings or in the specifications are intended to be nominal size or diameter and shall be interpreted as such.
 - 1. AWWA - American Water Works Association.
 - 2. ANSI - American National Standard Institute.
 - 3. ASTM - American Society for Testing & Materials.
- C. This specifications cover the following types of material:
 - 1. Ductile Iron
 - 2. Polyvinyl Chloride (PVC)
 - 3. HDPE

1.2 PIPE MARKING

Each length of pipe shall bear the name or trademark of the manufacturer, the location of the plant, and the date of manufacture. Each length shall likewise be marked to designate the class or strength of the pipe. The marking shall be made on the exterior or interior of the pipe barrel near the bell or groove end and shall be plainly visible. PVC pipe shall be green. HDPE pipe shall have permanently extruded stripes on three (3) or four (4) sides according to the following schedule:

Sanitary Sewer: Green Stripes

1.3 RELATION TO WATER MAINS AND STORM SEWERS

- A. All storm sewer crossings shall be in accordance with the WPWD Standards Section 03500. Should specific conditions prevent this separation, the Contractor shall notify the Westfield Public Works Department for specific instructions regarding the treatment of the separation. Force mains must be laid at least 10 feet horizontally from any existing or proposed storm sewer and whenever the force main crosses a storm sewer, it should be laid at least 18 inches below or above the main.

- B. All water main crossings must be in accordance with 327 IAC 3-6-9 and 327 IAC 8-3.2-9.
- C. Sewers must be laid at least 10 feet horizontally from any existing or proposed water main. The distance is to be measured outside edge to outside edge. Should specific conditions prevent this separation, the Contractor shall notify the WPWD for specific instructions regarding the treatment of the separation. Special conditions (existing conditions) may allow installation of the sewer closer to a water main, provided that the water main is in a separate trench or on an undisturbed earth shelf located on one side of the sewer and at an elevation so the bottom of the water main is at least 18 inches above the top of the sewer. It will be necessary to install 150 psi water main pipe and joints as sewer pipe for the congested areas.
- D. Whenever the sewer crosses a water main, it should be laid at least 18 inches below the main, or the water main should be relaid with fittings to cross over the sewer. The crossing shall be arranged so that the sewer joints will be equidistant and as far as possible from the water main joints. Any joints within a distance of 10 feet from either side of the crossing must be compression joints. All crossings must be at a minimum of 45 degrees from center lines of the sanitary sewer and the water main.
- E. When it is impossible to obtain proper horizontal and vertical separation as stipulated above, the sewer shall be designed and constructed equal to 150 psi water pipe, and shall be pressure tested to assure watertightness prior to backfilling. Maximum distance between sewer pipe joints and water pipe shall be provided where vertical separation is a problem.

PART 2 - PRODUCTS

2.1 GENERAL

All pipe, fittings, valves, and appurtenances shall be as shown on the drawings and specified in this Section. All pipe, fittings, valves, and appurtenances shall be new and unused. All pipe shall be a type approved by IDEM.

2.2 DUCTILE IRON PIPE

- A. Ductile iron pipe shall meet the requirements of ANSI A21.51 (AWWA C151) and the additional requirements specified herein. Design and manufacture pipe for a working pressure of 150 psi plus 100 psi surge and a safety factor of 2.0 and a depth of cover indicated on the drawings and

specified in this Section. Minimum thickness pressure class shall be class 350.

1. Pipe joints shall be push-on type. Joints shall meet the requirements of ANSI/AWWA A21.11/C111. Restrained joints shall be Lok-Fast, Lok-Tyte, MEGALUG, or approved equal.
2. Mark each length of pipe. Marking shall include pipe class, casting period, manufacturer's name or trademark, and year of manufacture. Marking shall meet the requirements of ANSI A21.51 (AWWA C151).

- B. Lining and Coating: Outside surfaces of the pipe and fittings shall be bituminous coated complying with ANSI/AWWA A21.51/C151 and ANSI/AWWA A21.10/C110.

2.3 PVC PIPE

A. Polyvinyl Chloride (PVC) Force Mains

1. Pipe
 - a. Polyvinyl chloride pipe shall meet the requirements of AWWA C900. The color of the pipe shall be green. Design and manufacture pipe for a working pressure of 150 psi plus 100 psi surge and a safety factor of 2.0 and a depth of cover indicated on the drawings and specified in this Section. The dimension ratio shall not be greater than 18.
 - b. Polyvinyl chloride pipe shall have cast-iron-pipe-equivalent outside diameter.
 - c. Pipe joints shall be push-on type. Joints shall meet the requirements of AWWA C900. Do not use solvent-cement joints.
 - d. Mark each length of pipe. Markings shall meet the requirements of AWWA C900.

2.4 HIGH DENSITY POLYETHYLENE (HDPE) FORCEMAIN

- A. Pipes: HDPE force main pipe shall meet the requirements for Type III, Grade P345 Polyethylene Material as defined in ASTM D1248 (PE 3408). The minimum pressure class/SDR rating acceptable shall be Class 200/SDR 11. The pipe shall be DIPS and shall have an interior diameter no less than the piping that it is connected to.
- B. Joints: Joints shall be of a heat fusion joining system. Pipe and fittings shall be thermal butt fusion, saddle fusion, or socket fusion in accordance with manufacturer recommended procedures and ASTM D2161. At the point of fusion, the outside diameter and minimum wall thickness of the fitting shall match the outside diameter and minimum wall thickness specifications of ASTM D1248 for the same size pipe.

Joining of the pipes and fittings shall be performed in accordance with ASTM D2774. Depending upon the installation requirements and site location, joining shall be performed within or outside the excavation. Joints of the pipe sections shall be smooth on the inside and internal projection beads shall not be greater than 3/16 inch.

The tensile strength at yield of the butt-fusion joints shall not be less than the pipe. A specimen of the pipe cut across the butt-fusion joints shall be tested in accordance with ASTM D638.

The manufacturer shall provide fusion training. The contractor and the onsite joint inspector shall be trained by the manufacturer or manufacturer's authorized representative.

The fusion equipment and operator shall be required to demonstrate successful field experience. Regarding fusion over 36" capability, the fusion unit shall be field tested for a period of five years and the fusion operator shall have pipe size experience of the same size pipe on this project for five years or longer.

- C. Fittings: All fitting shall be provided as indicated on the plans. HDPE Fittings shall be of the same material and class as the pipe and shall be manufactured by the manufacturer of the pipe. HDPE Elbows, tees, and wyes shall be manufactured by mitered fabrication. The manufacturer shall have a written specification for all standard mitered fittings, which establishes Quality Control criteria and tolerances. The manufacturer may be required to demonstrate its ability to produce product required by this specification.

Mechanical joint anchor fittings (MJ Adapter or Harvey Adapter) shall be used to transition from ductile iron to HDPE and from HDPE to PVC. The fitting shall be stronger than the pipe in that when it is subjected to tensile stress the pipe will pull apart before the fitting will pull out and the pipe will blow before the fitting will rupture under pressure.

The MJ Adapter shall have a pre-installed stainless steel stiffener, in accordance with Plastic Pipe Institute (PPI) recommendations, to neutralize point-loading, ACQ, creep and loss of gasket seal due to diameter contraction. The stiffener shall be engineered sufficiently thick to avoid radial buckling due to gasket pressure.

The MJ Adapter requires longer bolts and shall be sold with the modified longer bolt kit to avoid construction crew delays or improper installation with too short bolts.

All fittings for force mains or pressure rated fittings shall be rated according to the manufacturer's written specifications, and clearly labeled on the fittings as such.

- D. Installation: The installation shall conform to the requirements of the manufacturer, the AWWA Standard, and as indicated on the plans and specified herein.
- E. Marking and Certification: Each length of HDPE sanitary sewer shall be clearly marked with the Manufacturer's Name, Trade name or Trademark, Nominal pipe size, Pipe Stiffness, Production Code/Extrusion Code, Material Cell Class Designation and ASTM number.

The pipe manufacturer shall provide certification that the stress regression testing has been performed on the specific product. The said certification shall include a stress live curve per ASTM D2837. The stress regression testing shall have been performed in accordance with ASTM D2837, and the manufacturer shall provide a product supplying a minimum Hydrostatic Design Basis of 1,600 psi as determined by ASTM D2837. This certification shall also state that the pipe was manufactured from one specific resin in compliance with these specifications. The certificate shall state the specific resin used and its source.

2.5 FITTINGS

- A. Fittings shall be ductile iron. Fittings shall meet the requirements of ANSI/AWWA A21.10/C110 and ANSI/AWWA A21.53/C153. Design and manufacture fittings for a pressure rating of 250 psi.

1. Fitting joints shall be restrained mechanical joints or restrained push-on joints. Joints shall meet the requirements of ANSI/AWWA A21.11/C111. Restrained joints shall be used in addition to thrust blocking. Restrained joints shall be Lok-Fast, TR Flex, Lok-Ring, or approved equal. Pipe connecting to restrained joint fittings shall also have restrained joints as indicated on the drawings and specified in this Section.
2. Mark each fitting. Marking shall meet the requirements of ANSI/AWWA C110.

2.6 ADAPTERS

- A. Adapters from polyvinyl chloride force mains to victaulic or flange joint valves or fittings shall be ductile iron. Adapters shall meet the requirements of ANSI/AWWA C110. Design and manufacture adapters for a pressure rating of 250 psi.
- B. Line the inside surfaces of adapters with cement mortar lining and bituminous seal coating. Cement mortar lining and bituminous seal coating shall meet the requirements of ANSI/AWWA C104/A21.4. Coat outside surfaces of adapters with bituminous coating. Outside coating shall meet the requirements of ANSI/AWWA C110.
- C. Adapter ends connecting to polyvinyl chloride force mains shall have plain ends or mechanical joints. Mechanical joints shall meet the requirements of ANSI/AWWA C111/A21.11.
- D. Adapter ends connecting to victaulic or flange joint valves or fittings shall have joints complying with the specifications for the applicable valves or fittings.
- E. Adapters from ductile iron force mains to victaulic or flange joint valves or fittings shall be cast iron or ductile iron. Adapters shall meet the requirements of ANSI/AWWA C110. Design and manufacture adapters for a pressure rating of 250 psi.
 1. Adapter ends connecting to ductile iron force mains shall have plain ends, push-on joints, mechanical joints, or restrained push-on joints. Adapters with plain ends, push-on joints, or mechanical joints may be used where restrained joints are not required. Adapters shall have restrained push-on joints where restrained joint piping is required as indicated on the drawings and specified in this Section. Mechanical joints and push-on joints shall meet the

requirements of ANSI/AWWA A21.11/C111. Restrained joints shall be Lok-Fast, Lok-Tyte, MEGALUG, or approved equal.

2. Adapter ends connecting to victaulic or flange joint valves or fittings shall have joints complying with the specifications for the applicable valves or fittings.
3. Gaskets
 - a. Gaskets for polyvinyl chloride push-on joints shall meet the requirements of AWWA C900.
 - b. Gaskets for mechanical joints shall meet the requirements of ANSI/AWWA C111/A21.11.
4. Nuts and Bolts
 - a. Nuts and bolts for mechanical joints shall be high strength, heat treated, and cast iron. Nuts shall be hexagon nuts. Bolts shall be tee head bolts. Nuts and bolts shall meet the requirements of ANSI/AWWA C111/A21.11.

F. Gaskets for mechanical joints and push-on joints shall meet the requirements of ANSI/AWWA A21.11/C111.

G. Nuts and bolts for mechanical joints shall be high strength, heat treated, and cast iron. Nuts shall be hexagon nuts. Bolts shall be tee head bolts. Nuts and bolts shall meet the requirements of ANSI/AWWA A21.11/C111.

1. Nuts and bolts for restrained push-on joints shall meet the requirements of the joint manufacturer.

H. Polyethylene encasement for ductile iron force mains, when specifically called for on the drawings, shall meet the requirements of ANSI A21.5 (AWWA C105).

2.7 VALVES AND VALVE BOXES

- A. Eccentric Type Plug Valves: Plug valves shall be nonlubricated eccentric type with resilient faced plugs having mechanical joint or flanged ends.
 1. Port areas of 4 inch to 20 inch valves shall be at least 80% of full pipe area. Port area for 24 inch and larger valves shall be at least 70% of full pipe area.

2. Valve seats, valve plug stem sleeves and plug stem bushings shall be fabricated of materials which are corrosion and abrasive resistant. The corrosion resistance shall be such that exposure over a period of five years to domestic wastewater, industrial wastewater, domestic sludges or industrial sludges containing sulfuric acid, hydrochloric acid, acetic acid, mineral oils, vegetable oils, polymers, esters or acetones shall not result in sufficient corrosion to interfere with the serviceability of the plug valve.
 3. Seals shall be capable of being replaced while the line and valve remain in service, if under submerged conditions, thereby eliminating the need to take process units out of service.
 4. All exposed nuts, bolts, springs, and washers shall be plated with corrosion resistant material. Means of actuation shall be by lever, gear actuator, tee wrench, extension stem, or floor stand, as indicated.
 5. All plug valves shall be equipped with an underground operator.
 6. Plug valves 10 inch and larger shall be equipped with gear actuators. All gearing shall be enclosed and lubricated with seals provided on all shafts to prevent entry of dirt and fluid into the actuator. All shaft bearings shall be furnished with permanently lubricated bronze bearing bushings. Actuator shall clearly indicate valve positions, and an adjustable stop shall be provided to set closing torque. Valve stop shall be positive and shall not move due to repeated operation of the valve.
 7. Valves shall be DeZurik Series 100, Homestead Ballcentric, Dresser Style 800 X-Centric, or approved equal.
- B. Gate Valves: Buried gate valves 4 inch and larger shall be full ductile iron body, epoxy fusion bonded inside and out, non-rising stem gate valves. Valves shall meet the requirements of ANSI/AWWA C500 and shall have mechanical joint ends. Mechanical joints and joint accessories shall meet the requirements of ANSI/AWWA A21.11/C111. Valve opening direction (counter-clockwise) shall be consistent with operation of existing valves in the utility in which the valves are installed, unless otherwise directed by the Engineer.
1. Three-inch buried gate valves shall be iron body, non-rising stem gate valves. Valves shall meet the requirements of ANSI/AWWA C500, except ends shall be screwed. Screwed ends shall meet the

requirements of ANSI B16.3. Valve opening direction (counter-clockwise) shall be consistent with operation of existing valves in the utility in which the valves are installed, unless otherwise directed by the Engineer.

2. Gate valves 4 inch and larger installed above ground or in structures shall be iron body, outside screw, and yoke gate valves. Valves shall meet the requirements of ANSI/AWWA C500, except those parts of ANSI/AWWA C500 only applicable to non-rising stem gate valves and wrench nuts. Outside screw and yoke gate valves shall have flange joint ends and malleable iron handwheels. Flange joints and accessories shall meet the requirements of ANSI/AWWA C110. Nuts and bolts shall be cadmium plated. Gaskets shall be full face and shall be velumoid, or approved equal.
3. Gate valves smaller than 4 inch installed above ground or in structures shall be bronze, 125 lb. S.W.P. double disc, screwed-in bonnet, rising stem, inside screw gate valves with screwed ends and malleable iron handwheels. Valves shall meet the requirements of Federal Specification WW-V-54d for Class A, Type III valves.

- C. Valve boxes for plug valves and gate valves shall be cast iron. Valve boxes shall be two piece or three piece type. Each two piece box shall be complete with bottom section, top section, and cover. Each three piece box shall be complete with base, center section, top section, and cover. Valve boxes shall be extension type with slide or screw type adjustment. Each base and bottom section shall be the proper size for the valve served. Each valve box assembly shall be the proper length for the valve served. The minimum thickness of metal shall be 3/16 inch. Cast the word "SEWER" in each valve box cover.

2.8 SEWAGE AIR AND VACUUM VALVES

Sewage combination air and vacuum valves shall be as follows:

<u>Size</u>	<u>Specification</u>
2" x 1"	Val-Matic Co. No. 301 BWA, or approved equal
2" x 2"	Val-Matic Co. No. 302 BWA, ARI D-025 Threaded, or approved equal
3" x 3"	Val-Matic Co. No. 303 BWA, ARI D-025 Threaded, or approved equal

2.9 AIR AND VACUUM VALVE CHAMBERS

- A. Air and vacuum valve chambers shall be 4 foot diameter precast concrete manhole barrels with precast concrete flat slab tops. Precast manhole barrels shall meet the requirements of ASTM C478. Reference detail S-16.
- B. Air and vacuum valve chamber access frames and cover shall be Neenah R-1915-G, or equal. Cast the word "SEWER" in each cover.

2.10 BURIED INDICATING TAPE

- A. Metallic core or metallic-faced, acid- and alkali-resistant, or polyethylene plastic warning tape manufactured specifically for warning and identification of buried utility lines to be placed along the entire length of the force main, metallic and non-metallic. The tape shall have a 3 inch minimum width, color coded for the intended utility with warning and identification imprinted in bold black letters continuously over the entire tape length. Warning and identification to read "CAUTION, BURIED FORCE MAIN BELOW" or similar wording. Color and printing shall be permanent, unaffected by moisture or soil.
- B. For sanitary force main, locator wire shall be installed along the top and taped to the pipe. Access points for the locator wire shall be placed every 400 feet. Access points shall be 4 inch diameter PVC with threaded metallic caps painted green. Pipe shall be flush with grade. Wire shall be pulled to within 6 inches of the top of the pipe. For trench installations one (1) locate wire is acceptable. For trenchless installations three (3) locate wires are required for redundancy.

PART 3 - EXECUTION

3.1 INSPECTION AND REJECTION OF PIPE

- A. The quality of all materials, the process of manufacture, and the finished pipe shall be subject to inspection and approval by the Utility or designee. Such inspection may be made at the place of manufacture or on the construction site after delivery, or at both places; and the pipe shall be subject to rejection at any time on account of failure to meet any of the specifications' requirements even though sample pipes may have been accepted as satisfactory at the place of manufacture.

- B. Prior to being lowered into the trench, each pipe shall be carefully inspected, and those not meeting the specifications shall be rejected and shall be removed from the construction site.
- C. Any pipe which is damaged, bleached, or deemed unsuitable by the Utility or designee will be rejected and replaced solely at the Contractor's expense.

3.2 HANDLING AND CUTTING PIPE

- A. Pipe and fittings shall be handled carefully to avoid cracking or abrasion of the pipe coating. Each pipe section shall be handled into its position in the trench only in such manner approved by the Utility or designee. The Contractor shall be required to furnish slings, straps, and other approved devices to permit satisfactory support of all parts of the pipe when it is lifted.
- B. Any fitting showing a crack and any fitting or pipe which has received a severe blow that may have caused an incipient fracture, even though no such fracture can be seen, shall be marked as rejected and removed at once from the work.
- C. In any pipe showing a distinct crack and in which it is believed there is no incipient fracture beyond the limits of the visible crack, the cracked portion, if so approved, may be cut off by and at the expense of the Contractor before the pipe is laid so that the pipe used may be perfectly sound. The cut shall be made in the sound barrel at a point at least 12 inches from the visible limits of the crack.
- D. All cutting shall be done with a machine having steel cutters or knives adapted to the purpose. All cut ends shall be examined for possible cracks caused by cutting.

3.3 INSTALLATION OF PIPING

- A. The Contractor shall locate and verify exact size of all existing mains, both horizontally and vertically. Additionally, allow adequate time, after location and prior to making new connections, for changes in the connection location and size. Force mains shall only be tapped into manholes with approval by the Utility. Backfill excavation immediately after main is located and measured. Contractor shall notify the Utility and/or designee 48 hours prior to installation of piping.
- B. All piping shall be installed to accurate lines and grades and shall be supported, guided, or anchored as shown, as specified, or as necessary.

- C. Restrained joints shall be provided at vertical and horizontal deflection points, tees, and crosses, or as directed by the Utility.
- D. All piping installations shall be done in a neat and workmanlike manner.
- E. Install identification/location tape over all new non-metallic force main piping. See specification Section 02558 "Identification/Location Tape" and article 3.2 of this standard for material and installation requirements.

3.4 LAYING PIPE AND FITTINGS

- A. No defective pipe or fittings shall be placed in the work, and any piece found to be defective after having been placed shall be removed and replaced by a second piece and at the expense of the Contractor.
- B. Every pipe and fitting shall be cleaned of all debris, dirt, and other foreign material before being laid, and shall be kept clean until accepted in the completed work. Do not lay pipe in water or when the trench or weather conditions are unsuitable for proper installation.
- C. When bell and spigot pipe is laid, the bell of the pipe shall be cleaned of tar or other obstruction and wiped out before the clean spigot of the next pipe is inserted into it. The new pipe shall then be shoved home firmly against the back of the bell and securely held until the joint has been completed.

3.5 PIPE BEDDING AND HAUNCHING

- A. Each pipe section shall be laid in a firm foundation of sand and haunched and backfilled with care.
- B. Prior to pipe installation, carefully bring bedding material to grade along the entire length of pipe to be installed. To provide adequate support for the pipe, the following bedding procedures are recommended.
- C. Bedding material shall have a minimum thickness beneath the pipe of 6 inches or one-eighth of the outside diameter of the pipe, whichever is greater, and shall extend up the sides of the pipe one-sixth of the outside diameter of the pipe.
- D. The rigid pipe, such as concrete or ductile iron, backfill between the bedding material and a plane 12 inches over the top of the pipe shall be granular backfill.

- E. For flexible pipe such as PVC, the placement of embedment material, consisting of bedding, haunching, and initial backfill, must be done with care. The ability of the pipe to withstand loading in a trench depends a large part on the method employed in its installation. Sand shall be used to backfill between the bedding material and a plane 12 inches over the top of pipe. Care must be taken to not cause damage by compacting the material directly over the pipe.
- F. In yielding subsoils, the trench bottom shall be undercut to the depth necessary and backfilled with graded, crushed stone to form a firm foundation.
- G. Where excavation occurs in rock or hard shale, the trench bottom shall be undercut and a minimum 6 inches of sand bedding placed prior to pipe installation.

3.6 JOINTING

- A. Polyvinyl Chloride (PVC) Push-On Joints
 - 1. Clean the bell and spigot of the pipe sections being joined. Wipe the outside of each spigot and inside of each bell clean of all dirt and other foreign matter. Wipe each bell and spigot dry. Wipe each gasket clean of all dirt, dust, and other foreign material.
 - 2. Seat a gasket in the bell of the receiving pipe. Thoroughly lubricate the spigot end of the pipe being installed. Use the lubricant furnished by the pipe manufacturer. Center the spigot end of the pipe being installed in the bell of the receiving pipe. Support the pipe being installed so the pipe being installed is jointed along the centerline of the receiving pipe. Push or pull the pipe being installed home. After jointing, check the gasket to ensure the gasket has not pushed out of its seat and the gasket is uniformly compressed around the pipe.
 - 3. Deflect pipe after jointing, if deflection is required. The amount of deflection shall not exceed the limits recommended by the pipe manufacturer.

B. Mechanical Joints

1. Remove lumps, blisters, and excess bituminous coating from the bell and spigot end of each iron pipe, fittings, and valve. Wire brush the outside of each iron pipe or fitting spigot and inside of each bell. Wipe each bell, spigot, and ring gland clean of all dirt, oil, grease, and other foreign material. Wipe each bell, spigot, and ring gland dry. Wipe each gasket clean of all dirt, dust, and other foreign material.
2. Brush each spigot and gasket with soapy water. Slip a ring gland followed by a gasket over the spigot. Center the end of the pipe, fitting, or valve being installed on the end of the receiving pipe, fitting, or valve. Support the pipe, fitting, or valve being installed so the pipe, fitting, or valve being installed is jointed along the centerline of the receiving pipe, fitting, or valve. Push or pull the pipe, fitting, or valve being installed home. Push the gasket into position. Move the gland into position against the face of the gasket. Loosely assemble the joint bolts and nuts. Evenly tighten the nuts using a torque wrench. The torque shall be within the range listed in the following table:

<u>Pipe Size</u>	<u>Bolt Size</u>	<u>Torque Range</u>
4" thru 24"	3/4"	75 to 90 ft.-lb.
30" and 36"	1"	100 to 120 ft.-lb.
42" and 48"	1-1/4"	120 to 150 ft.-lb.

3. Deflect pipe, fittings, or valves after jointing, if deflection is required. The amount of deflection shall not exceed the limits shown in the following table:

<u>Pipe Size</u>	<u>Maximum Deflection Angle</u>	<u>Maximum Deflection Based Upon 18-Foot Pipe Length</u>
4"	8°-18'	31"
6"	7°-7'	27"
8"	5°-21'	20"
10"	5°-21'	20"
12"	5°-21'	20"
14"	3°35'	13-1/2"
16"	3°35'	13-1/2"
18"	3°0'	11"
20"	3°0'	11"

24"	2°23'	9"
30"	2°23'	9"
36"	2°5'	8"
42"	2°0'	8"
48"	2°0'	8"

C. Flange Joints

1. Remove antirust coating from machined surfaces. Clean joint surfaces of the pipe, fittings, and valves being joined. Wipe surfaces clean of all dirt, oil, grease, and other foreign material. Wipe surfaces dry. Wipe each gasket clean of all dirt, dust, and other foreign material.
2. Align the flange of the pipe, fitting, or valve being installed with the flange of the receiving pipe, fitting, or valve. Support the pipe, fittings, and valves being joined so the flanges are properly aligned. Lubricate bolts and nuts with a graphite and oil mixture prior to installation of bolts and nuts. Install gasket between the flanges. Loosely assemble bolts and nuts. Check gasket to ensure the gasket is in proper position. Evenly tighten bolts and nuts. Tighten bolts and nuts so the joint will not leak. Do not overtorque bolts and nuts.

3.7 RESTRAINING AND SUPPORTS

A. Thrust Blocking

1. Construct thrust blocks of concrete having a 28-day compressive strength of not less than 4,000 psi.
2. Lubricate fitting surfaces and wrap fitting with plastic to prevent bonding between fittings and thrust blocks.
3. Construct thrust blocks between fittings to be restrained and undisturbed soil. The area of thrust blocking bearing on undisturbed soil shall not be less than the area indicated on the drawings. Construct thrust blocking so pipe and joints are accessible for repair and joint flexibility is not impaired.

- B. Restrained Joint Piping: Restrained joint piping shall be as specified in this Section. Distance from fitting to end of restraint shall not be less than that indicated on the drawings.

C. Pipe Supports

1. Furnish and install supports required to hold pipe, fittings, and valves at the lines and grades indicated on the drawings and without strain upon pipe, fittings, and valves.
2. Support exposed piping by suitable saddle stands, concrete piers, or hangers.
3. Locate supports where necessary and not less than 8 feet on center.

3.8 HYDROSTATIC TEST

- A. A leakage test must be successfully performed on the new force main in accordance with the following provisions:
 1. Said test shall include all force main in this contract as shown on the drawings. The Contractor shall make arrangements with the Utility and/or designee for scheduling the test after the piping has been accepted as being ready for testing. All concrete thrust blocks shall have been in place for a period of at least ten days prior to the test. The test shall be performed on the day mutually agreed upon and in the presence of the Utility and/or designee.
 2. Water for testing shall be obtained by the Contractor at his cost. The Contractor shall furnish all necessary equipment, piping, pumps, fittings, gauges, and operating personnel to properly conduct the test. The system shall be tested in conformance with AWWA C600 at static pressure of 100 pounds per square inch over a period of not less than two consecutive hours. The system will not be acceptable until all leaks have been repaired to the satisfaction of the Utility and/or designee.
 3. At the option of the Contractor, the force main may be tested in sections approximately 500 feet in length (subject to the approval of the Utility and/or designee); and upon satisfactory completion of the leakage test, the trench shall be backfilled as specified.
- B. When push on joints are used, the Contractor shall completely fill the pipe with water and apply sufficient pressure to set the joint gaskets before commencing the leakage test outlined above.

END OF SECTION 02732